THE TWINE TRIANGULAR STITCH FOR GASTRO- AND ENTERO-ENTEROSTOMY.

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In presenting this paper, I wish to state that the facts recorded in it represent the result of the work of a number of undergraduate students in the medical department of Columbia University. Mr. Donald Gordon built the animal cage; Messrs. Kussler and Thomas perfected the knot as it is used to-day; Mr. Charles K. Stillman has made the drawings for the illustrations. Mr. Eggers has taken charge of the laboratory, and has operated on many occasions with the assistance of less trained students. The results, then, represent a portion of the studies carried on by the under-graduate students of the Surgical Research Laboratory of Columbia.

The object of this paper is to present in full detail the method of application of the twine triangular ligature and to report the experimental and clinical status of the method.

Fig. 1 shows a diagrammatic outline of a conventionalized colon and mesocolon with the posterior wall of the stomach pushed down from above through the incised mesentery. After selecting the portion of the small gut which is to be united to the stomach, a point is chosen upon it about 90° from its mesentery, and, upon determining the portion of the gastric surface where the stoma is to be made, the gut and stomach may be held by an assistant, as shown in Fig. 2. We are indebted to Dr. Walter B. Cannon, of the Harvard Medical School, for this technical use of the word "stoma," he having first used it in describing his well-known observations on the motor activities of the stomach. The 90° distance from the mesentery is chosen for the line of insertion of the posterior row of continuous Lembert stitches so that when the triangular suture is finished and the anterior Lembert layer is closed

around it, about 180° of the circumference will have been used up in making the stoma. The remaining 180°, then, constitute a lumen through which food may without difficulty pass, pending the sloughing out of the stitch. In human beings, the length of this Lembert should probably in no case be less than ten centimetres. A few centimetres of this Lembert continuous stitch should be left, as shown on the slide, at the point of beginning, to serve as a guide in the completion of the stitch, and knots may be tied at intervals, if desired. It has

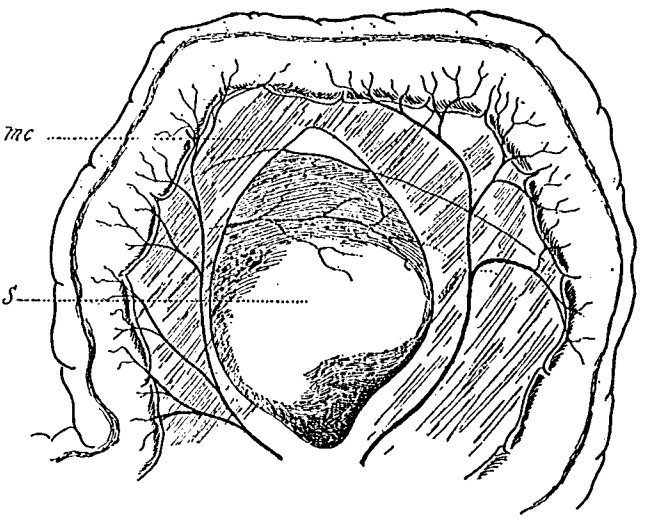

FIG. 1.—Exposure of posterior gastric wall.

been our custom at the Laboratory to tie the Lembert before beginning the insertion of the triangular stitch, but Dr. Abbe has shown that this is not necessary.

The next step in the technique, as shown in Fig. 3, is to insert the triangular ligature. The beginning and end of the Lembert serve as guides for the basic angles of the triangles. The needle, then, is thrust into either the gut or the stomach at the apex, which lies in the perpendicular erected at the centre of the base and less than a diameter of the gut distant from it, and is carried in either direction to one or other of the points

named. The ligature is shown as beginning in the stomach, *A*, near the vessels of the greater curvature. It then passes to *B* and emerges. The distance from *B* to the extremity of the Lembert should not be more than one-half centimetre. The needle enters at *C*, care being taken to pierce the mucous membrane, and the point is carried parallel to the Lembert to *D*, one-half centimetre from its termination. The needle is then

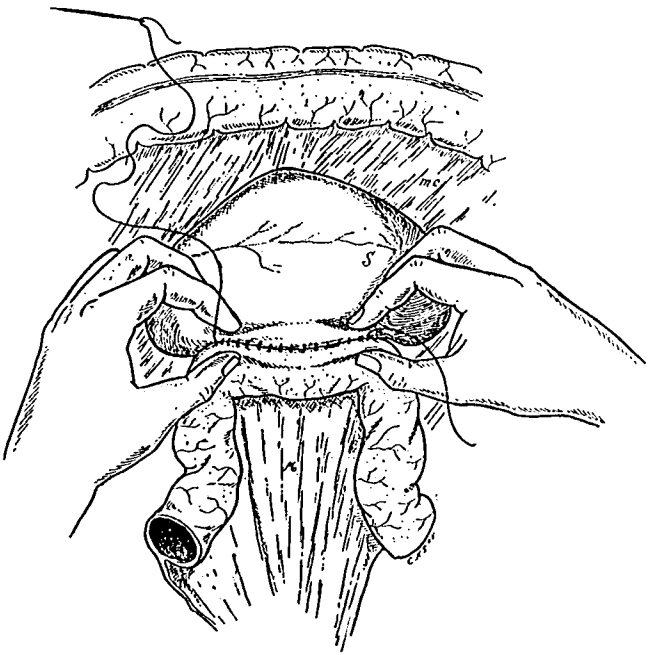

FIG. 2.—Insertion of posterior row of Lembert stitches.

plunged directly into the stomach at *E*, to emerge at the point of beginning. In this way the first triangle is completed.

Fig. 4 shows the appearance of the part after the insertion of the second triangle. Letters have here been omitted for the sake of clearness, but the arrows show the direction of the twine, and it is, of course, directly inverse to that taken in making the first triangle. It will be noted, as soon as the loop

is drawn down and the apices are approximated, that the entire stitch is out of sight within the lumen except at the angles of the triangle, where in each case it crosses twice.

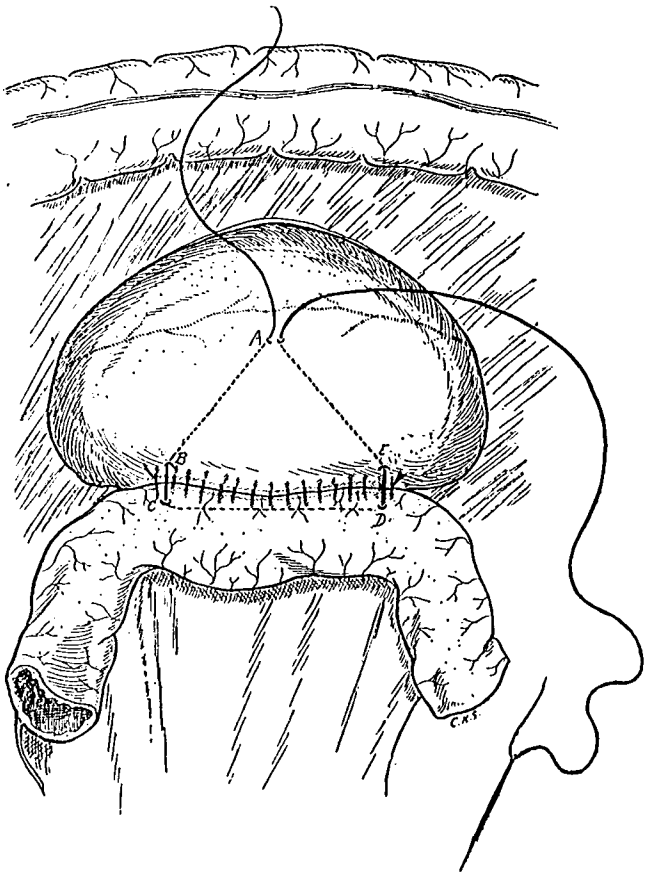

FIG. 3.—Insertion of the first triangle.

The stitch may seem complicated at first sight, but if the method be analyzed it will be found to be simple enough. That this assertion is well grounded is proved by the fact that none of the students have had the least difficulty in learning to insert

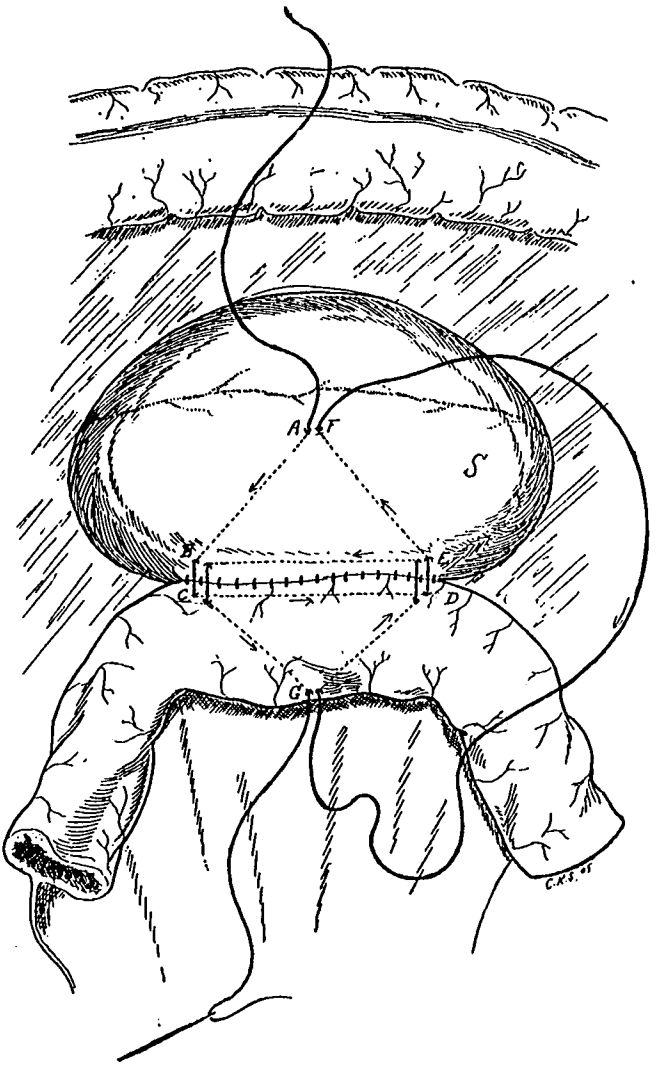

FIG. 4.—Insertion of the second triangle.

it. It should be remembered that the stitch consists simply of two isosceles or equilateral triangles superimposed. The apex of one is in the stomach, and its base lies beyond the Lembert stitch in the intestine. The apex of the other is in the intestine, and its base lies in the stomach beyond the continuous Lembert first mentioned. The length of the perpendicular of the intestinal triangle is easily determined by its relation to the

FIG. 5.—Approximating the apices.

diameter of the gut. It should be just a little less than equal to it, the difference allowing for the insertion of the Lembert stitches. This, in other words, disposes of the 180° of the circumference, which it has been found wise to allot to the stitch.

So far, it may be stated that the only point of importance in executing the technique, aside from following the direction

of the triangles as indicated, is that each time the needle is inserted it should be positively ascertained that it has pierced the mucous membrane of both viscera. This may readily be done by carrying it to one side or the other and gently feeling for the point through the wall of the viscus. The needle should not be too sharp; it should be round, straight, and about eight centimetres in length. It is convenient, although by no means necessary, while tying the first knot of the ligature, to press the row of Lembert stitches and the bases of the triangles downward. This juxtaposes the two triangular surfaces and raises them into a vertical plane. No effort should be made to tighten the ligature until after the first single knot has been made. It is further assuring to seize the twine at the two angles, just before the Lembert is folded down and the first knot in the twine is tied, with a pair of thumb forceps, and make sure by their freedom of motion that the needle has not, by any chance, transfixed the twine in any part of its varied course. This accident has happened once at the Laboratory.

Another technical point is that the twine of the second triangle should be brought out at the angles as nearly through the same needle holes as those caused by the insertion of the first triangle. A failure to do this probably caused the interesting condition seen in Fig. 11, where at *D* the twine triangular stitch is seen caught by a small bridge of tissue and having slung across it a hair ball, *C*, which had accumulated there in about two weeks' time as a result of the dog's having licked his wound. This is the only instance of the kind which has occurred at the Laboratory, but it is an interesting one, and suggests the importance of the details just suggested. If this rule be adhered to, such bridges of tissue cannot be left at the angles to hold the twine.

Fig. 6 represents a convenient mode of tightening the suture, and is the method usually employed at the Laboratory. As already emphasized, the experimental results amply justify the statement that a failure of the twine to cut through is ascribable to the failure of the operator to tie it tight enough, and not to any fault of the triangular ligature. Dr. John A. Bodine has graphically said, "I prefer this method to any

other because success depends entirely upon my own efforts, there being no faulty spring, as is always possible in the case of the Murphy button, or rotted ligature, as may be the case in the McGraw technique. If I get my brute strength down on the knot in that twine, I know those triangles have got to slough out."

Fig. 7 shows the Lembert completed and tied at the point of beginning, which, it will be remembered, was left long for this purpose. There is a distinct tendency, seen particularly when the technique is executed upon the gut of a dog, for the twine to cause a number of radiating folds which necessitate

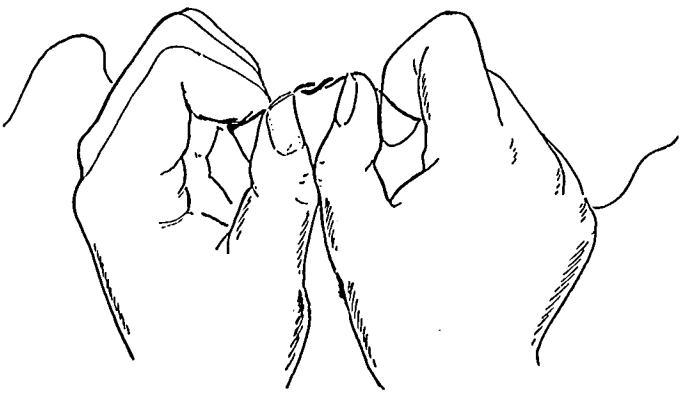

FIG. 6.—A method of making the knot absolutely tight.

a little care in the completion of the Lembert. In man they are much less marked, probably because the gut is more pliable, and also because it is of much greater diameter and much thinner. A point which we have usually tried to make in finishing the Lembert has been, so far as possible, to take the stitches at the bottom of these sulci. They are thus easily obliterated and give rise to no trouble.

This completes the description of the method of inserting the twine; and now I wish to turn to some of the experimental considerations which have been met with in the course of our work. It has been a moot point whether the twine would cut out as surely as does the McGraw elastic. After

careful experimentation with the two materials, it was found that in point of time as well as in certainty of operation they were identical.

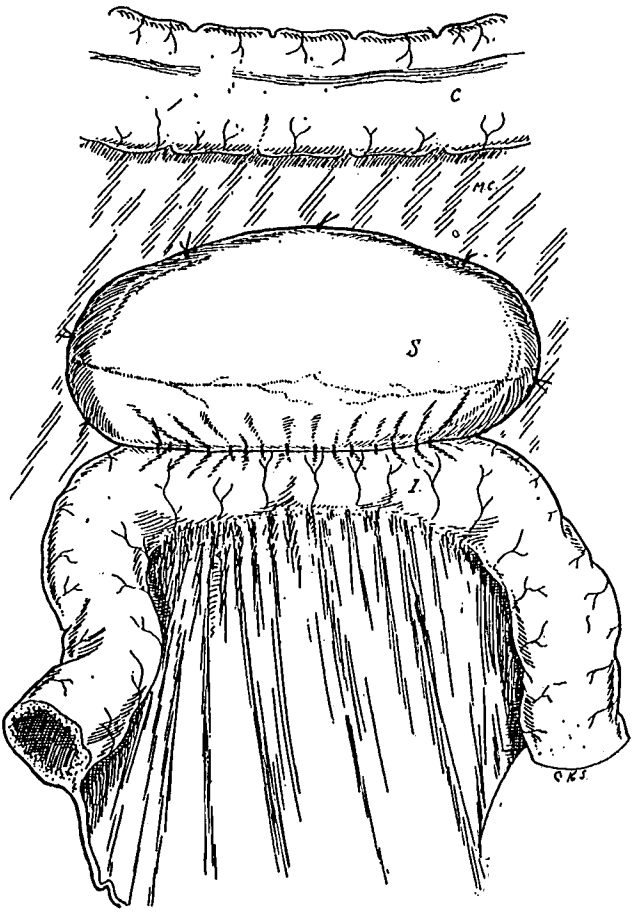

FIG. 7.—The anterior row of Lembert stitches has been completed.

Fig. 8 is a microphotgraph made from a section which was taken from dog No. 30. It shows the path of the twine triangular ligature after it had been *in situ* for about forty-

FIG. 8.—Note the line of necrotic tissue (about an inch wide) extending vertically through the photograph.

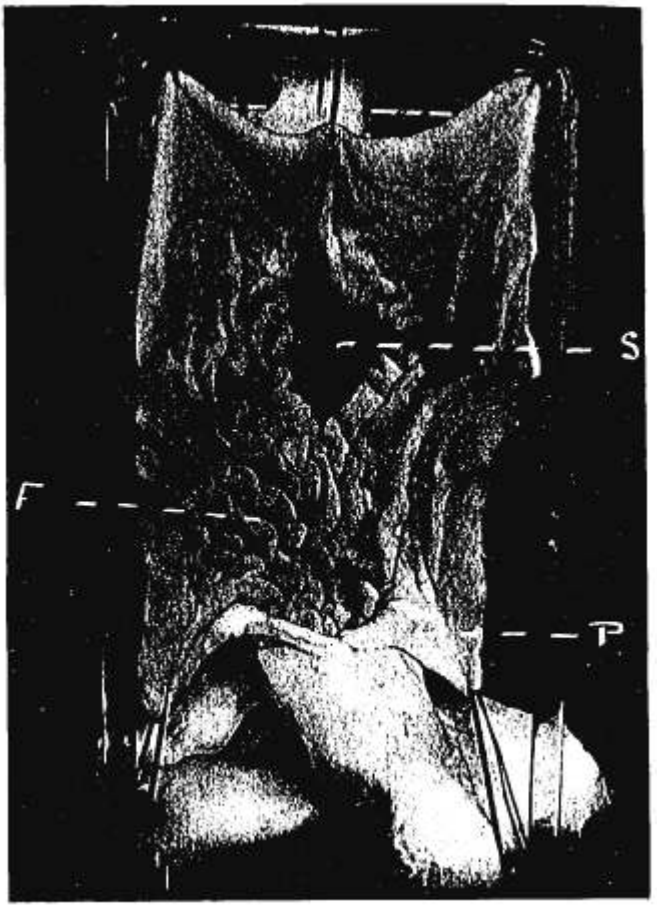

FIG. 9.—The stomach has been opened and the gut split. When retracted to the glass frame, the stoma shows clearly.

eight hours. Necrosis appearing as a broad band, marked *N*, is very plainly to be seen. It extends entirely across the field, and portions of the necrotic tissue, to the right and left, can be seen to have already sloughed away. In this case the triangular opening was about one-half completed, and the whole mass, including the string, would have been detached within twelve to eighteen hours. A dark fold is seen in the centre of the necrotic path. This is an artifact, but it happens to serve as a guide to the necrotic part.

Fig. 9 shows a very satisfactory stoma measuring twelve centimetres in circumference. This is about as large as can be made in a dog, on account of the limited size of the gut. In the fresh state it easily admitted the first and second fingers together for their entire length. It appears incredible that such an opening should sensibly contract, although we shall not know the certain answer to the question of degrees of contracture of the stoma when the pylorus is patent until some experiments, for some time under consideration at the Surgical Research Laboratory, are completed.

The opening made by the twine triangular stitch, as shown in this specimen, seems to possess the advantages which are universally conceded to the openings made by the Murphy button and by the McGraw ligature. The button punches out and the McGraw gives length. There is no question that there has been a very distinct punching out in all the specimens made by the triangular ligature. Furthermore, as in the case of the McGraw, there is an element of length represented by the base of the triangle which may be made as long as desired. This cannot possibly be obtained by the ordinary Murphy button. That this long diameter is desirable is shown by the fact that Dr. Blake, in seeking to solve the question, devised a most ingenious modification of the Murphy button. It is so patterned as to give length to the stoma as well as breadth.

The pyloric opening is shown at *P* and the heavy rugæ or folds at *F*. This specimen was photographed partly because it yielded an excellent demonstration of the capabilities of the twine triangular stitch and partly because of these well-marked rugæ. It has been suggested that the twine, when

tightly tied, would pucker the mucous membrane and leave it in an undesirable condition. This stoma was made as near to the pylorus as convenient, and the photograph shows that the rugæ, while abundant at the lower portion of the stoma, are absent above, and, further, that they are more plentiful at the pylorus than at any part of the circumference of the stoma. It appears, after a study of this specimen and of others, that the suggestion, although apparently based on reasonable grounds, is, fortunately, a more theoretical than practical objection to the technique. Furthermore, inasmuch as the mucous membrane cannot grow together, if uninjured, even if tightly apposed, it seems justifiable to consider this objection as negated.

Fig. 10 represents a stoma which had been established for just three months. It will be noted that its edges are much smoother than those in the photograph just shown, and, furthermore, that the opening has become more or less spherical. The gastric mucosa, marked *G M*, has rolled a distance of about a centimetre into the duodenum. The dog, a large Newfoundland, lived without discomfort for about three months after the operation, and gained over ten pounds while under our care. *D* represents the cut and infolded pylorus, this operation having been done three days after the triangular stitch was inserted. As yet, we have been unable satisfactorily to block the pylorus except by section and infolding, silk and silver-wire ligation having been shown to be absolutely untrustworthy.

One of the most interesting conditions brought to light by this experimental work is the fact that in establishing gastro-enterostomy with the twine, unless the division of the gut be made thirty-five or more centimetres from the pylorus, the dog will die in from twelve to thirty-six hours, with symptoms resembling tetany. It is therefore necessary, in order to perform gastro-enterostomy with the twine and close the pylorus or duodenum, to do the work in two operations, separated by at least seventy-two hours. The twine must be put in first and the gut division done after the stoma is open. This is, however, not true if, as stated, division be practised thirty-

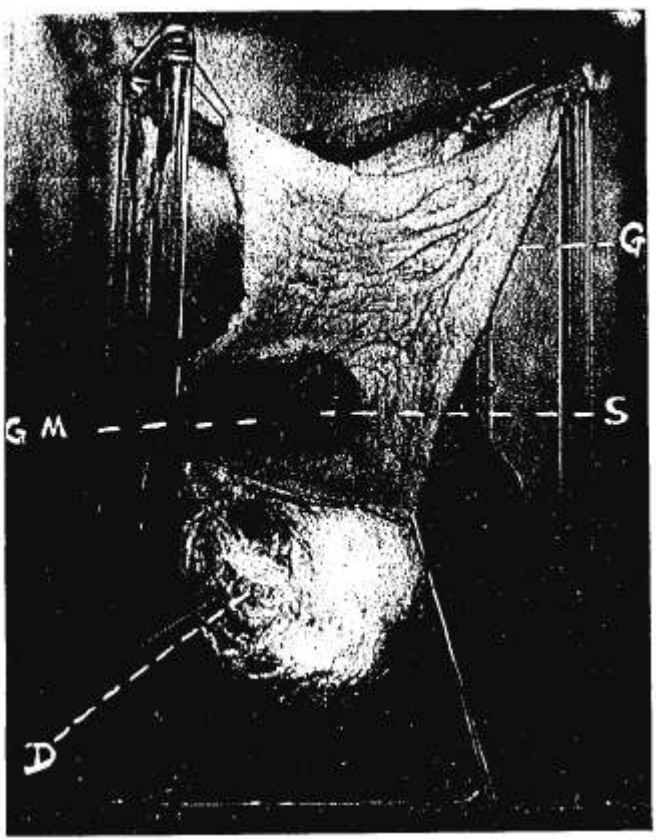

FIG. 10.—Gastro-enterostomy. Note evagination of gastric mucosa showing desirability of a "punched-out" opening.

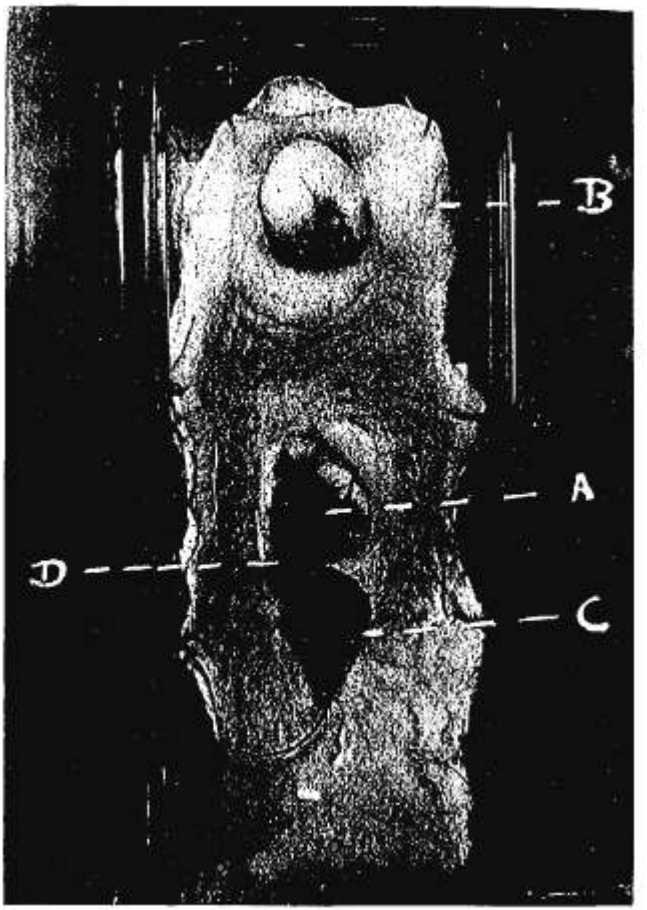

FIG. 11.—Gastro-enterostomy. Looking towards mucosa of stomach and through "stroma." Note hair-ball.

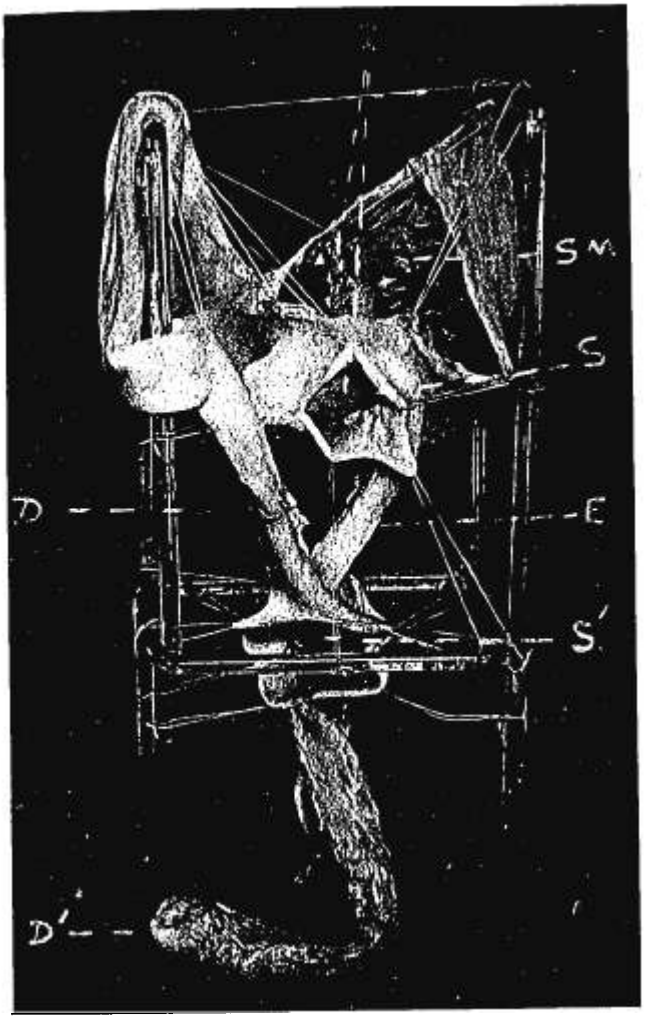

FIG. 12.—V operation. Note invagination.

five or more centimetres from the pylorus. The discussion of this singular fact will be the subject of a subsequent communication from the Laboratory.

Fig. 11 shows a very interesting condition, already referred to, namely, the possibility of the retention of the twine triangular stitch at one of the apices of the triangle. The dog was a large, black Newfoundland, who licked the neighborhood of his wound continuously. The large hair ball, *C*, was fast in the loop of the ligature, *D*. *B* in this photograph shows the stump of the inturned gut. It will be noted in all these specimens that particular pains have been taken, in mounting, not to put any undue tension upon the parts, but to leave them sufficiently lax so that the normal relations shall not be disturbed. The stomata shown average about eight centimetres in circumference.

Fig. 12 represents a Y gastro-enterostomy. The two stomata shown at *S* and *S'*, as made by the triangular stitch, are seen to be perfect. The specimen, in addition to this, demonstrates an interesting pathological condition, and one which shows most pertinently the importance of experimental work on animals. The operation was completed by severing and infolding that portion of the proximal loop which lay between the entero- and gastro-enterostomy. The dog recovered so rapidly that it seemed hardly credible that an operation of such magnitude had been performed upon him. At the end of a week he was killed; his bowels and all other functions having been in perfect condition. *S M* is the stomach mucosa and *I* the intussusceptum, which, originally severed and unfolded about twelve centimetres from the stoma, had in a week's time, and without interfering with the health of the dog, turned itself inside out through the stoma into the stomach. Fortunately, the stoma, *S*, was sufficiently large not only to accommodate this mass, but to give a perfectly free opening for the passage of food as well. Dr. Brewer tells me that Crile has had this very accident happen on the human being; and this specimen supports Crile's contention that this operation should never be done without subsequently attaching this free portion of the proximal loop so as to prevent its invagination.

This Y gastro-enterostomy can be done more rapidly with the twine triangular stitch than by the ordinary end-to-side anastomosis. The two stomata and the folding in require, at the outside, ten minutes each. Obviously, this method closes the alimentary canal absolutely for at least forty-eight hours. In the case of the dog, such closure as already cited results in death from tetanoid symptoms. It was at the instance of Dr. George E. Brewer that these Y gastro-enterostomies were attempted. Not wishing to leave as much as thirty-five centimetres between the pylorus and the site of the intestinal division, the amount of gut already alluded to as necessary to prevent death, pending the cutting out of the twine ligature, we have, in several instances, had recourse to the following modifications of the usual technique. Immediately after the insertion of the triangle and before the apices are tied together, we have lifted the centres of the triangles with a mouse-tooth forceps and cut out a small piece of the wall with curved scissors. Immediately after this the knot in the twine ligature is tied. It might reasonably be thought that the tying of the twine would obliterate the opening between the opposing viscera. Enough experimental work has not been done upon this point to warrant positive statements, but in two cases in which it has been employed an opening has been made in the viscus and a blunt instrument, an artery clamp, has been gently passed down to the region of the ligature and has slipped through into the opposing organ without any force whatever being used. The tying of the twine does not, therefore, necessarily occlude the lumen which has been made in the opposing triangles as described.

Immediate and justifiable exception to this technique is anticipated by stating that we have had no less than three deaths from peritonitis due to leakage around the single row of Lembert stitches. If, therefore, this technique be employed, it may already be positively stated that a double row of Lembert stitches must certainly be employed. We had hoped that the twine ligature would play the part of one of these rôles, but the difficulty is that the mucous membrane pouts so that, although tied tightly, it does not control leakage. About 50 per cent. of the cases in which the triangle has been cut out

have resulted in perforative peritonitis. A double row of sutures has not yet been experimented with.

Shock after Operation.—We have learned not to operate on dogs until after they have been in the cage (described in ANNALS OF SURGERY, June, 1904) and on a diet of Sprat's Dog Biscuits for at least three days. Whether the increased resistance which certainly develops after this period is due to the animal's becoming accustomed to his environment, or whether the very excellent biscuits are responsible for it, is not known. Dogs operated upon, under the limitations above described, suffer no shock, and appear to have no pain after the twine triangular stitch has been put in. As a rule, within twelve hours of the time of operation they drink water and in twenty-four hours take milk freely. The absence of shock and pain is a well-known characteristic of the McGraw elastic ligature, and is, therefore, naturally to be looked for if twine be employed in its stead. There is to be expected in dogs, and in human beings as well, a moderate amount of vomiting of brown material.

The clinical reports from the cases operated upon by Drs. Bodine, Lilienthal, Abbe, and Meyer show an absence of shock in human beings equal to that observed in dogs when twine is employed.

Character of the Twine.—At the Laboratory we make use of strong white twine, used in the dissecting-room for suspending the extremities of subjects. If the braided line be used, 22-thread Cuttyhunk is recommended. What we have used is twisted, not braided. Neither the writer nor any of the students have yet been able to break it with the hands. Dr. Abbe used this twine in his recent case, and was also unable to break it even with his gloved hands. It is important that the twine used should be as strong as this, because, as recorded in one of Dr. Lilienthal's cases, the silk broke while he was inserting it. An advantage of using a twisted rather than a braided twine lies in the fact that, in all probability, tighter pressure can be made upon the tissues to be constricted with the twisted material. It offers less resistance to the tissues, and, furthermore, causes less friction upon itself when the first knot

is made taut. A possible objection to it, and one which we have on one occasion encountered at the Laboratory, lies in the fact that during its insertion the twine may uncoil slightly and the operator may, as already stated, inadvertently pass the needle through one of the coils without encountering sufficient resistance to realize it. It has become our custom, therefore, in view of this accident, to seize the stitch at about its centre with a thumb forceps and make sure that it is entirely free before the twine is tied.

Advantages of Using Twine instead of Elastic.—That a piece of twine eight or ten centimetres in length, if it will do equally good work, is to be preferred to any form of metallic button, is hardly to be denied. This is true whether the ordinary instrument devised by Dr. Murphy be used, the equally ingenious collapsible aluminum bobbin of Dr. Harrington, or even the new French button in the form of a key-ring. Intestinal obstruction and death have been caused simply by the weight of the Murphy button. Aside from the fact that these instruments are likely, on the one hand, to slough into the peritoneal cavity, or, on the other, not to loosen from their attachment, or even, perchance, to fall into the stomach, there is one inalienable characteristic common both to the metallic adjuncts and to the McGraw elastic ligature as well. Success of the operation depends, in great part, upon the intrinsic characteristics of the instrument or material, and by no means entirely upon the skill of the surgeon. He is, in other words, in great measure dependent upon an instrument maker or upon a dealer in india rubber. If the twine triangular stitch fails, however, the operator has no one to blame but himself. He has not tied the twine tight enough, if the stoma fails to be created. In other words, the twine triangular ligature depends for its success entirely upon the skill of the man who is putting it in, and not upon the problematical strength of an elastic band or upon the variable temper of a spring, as in the case of the Murphy button. Furthermore, a piece of twine may be had anywhere and upon all occasions, whereas the elastic ligature must be procured from a special maker, must be flawless, and, above all things, must be new. Ligatures which have been

imported to the Laboratory directly from Detroit broke while being inserted after they had been in our hands less than five weeks.

Dr. John A. Bodine had a similar experience at the Polyclinic Hospital while endeavoring to insert a McGraw elastic ligature which he had on the very day of the operation obtained from one of the leading instrument houses of this city.

The Results of the Insertion of the Stitch in Human Beings.—The following named gentlemen have used the technique, and have kindly signified their willingness to allow me to report their cases: Dr. John A. Bodine, Dr. Howard Lilienthal, Dr. Robert Abbe, and Dr. Willy Meyer.

Dr. Bodine was the first surgeon to use the stitch on a human being. The history of his case, as abstracted from the Polyclinic Hospital Records, is as follows:

CASE I.—Mrs. C. G., admitted June 1, 1904, to the Polyclinic Hospital, found to be suffering from pyloric stenosis and assigned to the medical side. Her weight was eighty-five pounds. She was given strychnine, hydrochloric acid, and potassium iodide by enema, and put on a diet of broth and buttermilk; gastric lavage. On June 9 she weighed ninety pounds; on June 21 she was discharged improved.

On October 3 she was readmitted to the Polyclinic Hospital, and assigned to the service of Dr. John A. Bodine. She had lost all that she had gained during her previous visit to the hospital, was exceedingly weak, and seemed in a dying condition. Patient said she had been unable to retain anything, and had vomited almost continuously for the last three months; she complained of a constant pain over the region of the pylorus, which was so severe that she was willing to have operative intervention. On palpation, the abdominal walls were found rigid; nevertheless, a very distinct tumor in the region was easily mapped out. It was extremely tender but not entirely fixed. The urine was normal, although much diminished in amount. Owing to the extremely debilitated condition of the patient and to the fact that the tumor was palpable, no examination was made of the gastric contents; but the patient was operated upon just as soon as she had rallied from the exertion of her journey to the hospital.

On October 5 the triangular stitch was inserted by Dr. Bodine, and tied as tightly as possible. A posterior gastro-enterostomy was made without entero-enterostomy; time of operation, thirteen minutes.

October 6, vomiting; pain; sterile water given freely, as it made the vomiting easier and modified the thirst; temperature normal; pulse, 96. October 7, nausea and vomiting; patient very weak; oxygen given; vomited frequently small quantities of dark material. This was evidently the slough from the stitch. October 8, continued vomiting a black material. Late in the afternoon very tympanitic and restless; continued regurgitation. On the night of the 8th, or seventy-two hours after operation, she fell asleep, and awakened much brighter and more comfortable. This undoubtedly marked the period of the falling out of the slough.

From this time on the history of the patient was that of uninterrupted convalescence. An interesting point to be observed was that, during the third day, she was given twenty-four ounces by mouth and actually vomited up twenty-six, the additional two ounces being, supposedly, secretion from the walls of the stomach. The patient has recently reported herself as being able to attend her household duties without fatigue; she has gained forty-five pounds, and can eat corned beef and sauer-kraut with perfect comfort.

The clinical diagnosis of carcinoma of the pylorus made at the time of operation, but based more particularly upon the clinical evidences, is probably erroneous. Owing to the patient's extreme prostration at the time of operation, almost no examination of the parts seemed justifiable. The entire pylorus was, however, blocked by a large tumor, and the stomach was moderately dilated.

CASE II.—Mr. J. L.; bookkeeper; aged forty-nine years; admitted to Mt. Sinai Hospital, and transferred to surgical division, December 14, 1904; discharged January 7, 1905. Diagnosis, pyloric obstruction from carcinoma. Operation, gastro-enterostomy by Maury's triangular stitch.

Family history negative. Previous history negative.

Present illness. One year ago began to note gradual loss of

health and strength. Pain in the upper right abdomen became pronounced, and was particularly marked ten or fifteen minutes after eating; flatulence was almost continuous. There was at no time hæmatemesis or vomiting; constipation had been marked, and œdema of the legs had been occasionally present; he had lost eighteen pounds.

Physical, December 4, 1904. Cachexia. No icterus. Abdomen, inconstant visible peristalsis. Stomach percussion note two inches below umbilicus. Inflation and transillumination made outlines very distinct. This was seen with particular clearness after the administration of a fluorescent medium.

Laboratory findings. Free hydrochloric acid absent; lactic acid present. Total acidity, 60. Guaiac test positive. Urine negative.

Operation, December 14, 1904. Dr. Howard Lilienthal. Posterior gastro-enterostomy by Maury's triangular stitch.

December 15. General condition good; practically no reaction to the operation whatsoever.

December 27, patient out of bed and eating.

January 6, 1905, discharged, improved.

CASE III.—J. H.; aged fifty-nine years; admitted to Mt. Sinai Hospital, February 15, 1905; died February 21. Diagnosis, gastric carcinoma. Operation, gastrectomy and posterior gastro-enterostomy by Maury's triangular ligature.

Family history negative. Previous history, typhoid twenty-five years ago.

Present attack began eight months ago. First symptom, vomited one-half hour after eating breakfast, retained other meals. Eructations and general evidence of dyspepsia shortly followed. Pain for last month only. Starts from epigastrium and radiates to sternum. Constipation. No movement for past eight days. Loss of strength rapid and marked.

February 14, stomach analysis; no free HCl. Blood and lactic acid.

February 15, two quarts of dark grumous fluid with rancid smell removed from stomach. Modified Ewald. Total acidity, 84. Guaiac positive. Boas-Oppler and muscle fibres present.

General physical negative. Patient has lost much weight and has distinct cachectic look.

Operation, February 17. Dr. Howard Lilienthal. Distal

one-half of stomach resected. Gastric wound closed by three layers of silk sutures. Duodenal stump closed with purse-string ligature and cauterized with pure carbolic. It could not be turned in. Maury's twine triangular stitch was inserted between the remaining gastric pouch and the upper portion of the jejunum. A drain was passed down to the duodenal stump and the abdominal wound closed.

February 18 to 21, patient's condition progressively bad. Very foul odor to the drain-tube when removed at first dressing.

Patient died February 21. Wound examination revealed general purulent peritonitis, which was shown to have had its origin in a small fistula through the gastric line of suture. This opening easily admitted a good-sized probe and communicated directly with the peritoneal cavity.

The gastric walls were very œdematous as well as hypertrophied. They were approximately double the usual thickness. The Maury triangular stitch had not yet sloughed out, although the triangles were distinctly necrotic and drainage had begun at the angles.*

CASE IV.—J. C.; aged thirty-three years; tailor; admitted to Mt. Sinai Hospital, February 22, 1905; discharged, March 14. Result, cured. Diagnosis, pyloric stricture. Operation, gastro-enterostomy by Maury's twine triangular ligature.

Previous history. Typhoid fifteen years ago.

Present illness. Onset five months ago with sharp pain in right hypochondrium radiating to right shoulder. No jaundice. Pain has become progressively worse. Patient in bed for most of the time for last three months. Vomited frequently.

Physical. General condition good. Glands negative. Abdomen normally tympanitic.

Operation, February 24. Dr. Howard Lilienthal. All structures in neighborhood of pylorus found adherent by bands of adhesions. Transverse colon included in mass. When adhesions were freed, which was accomplished with great difficulty, pylorus was found to barely admit tip of finger. Mass now determined to be in wall of pyloric portion of the stomach. The triangular stitch was inserted.

* This operation was justified by the fact that Ochsner had reported the successful employment of a similar technique, using the McGraw ligature instead of the twine.

Postoperative history. There was practically no reaction from the operation. This patient was very noisy and suffered intense pain before operation. This continued for a short time after the insertion of the ligature, and to it was added vomiting of a moderate amount of coffee-ground fluid. Six days after operation patient had two severe attacks of pain, which was located in same situation as before operation.

March 8, twelve days after operation, silk ligature was found in stool, a dose of castor oil having been administered. The ligature had undergone extensive digestive processes.

March 13, discharged cured.

CASE V.—D. F.; aged fifty-five years. Diagnosis, pyloric stenosis and periduodenal abscess. Admitted to Mt. Sinai Hospital, March 6, 1905. Died March 29.

Previous history, typhoid thirty years ago.

Present illness. Unable to sleep for last two months owing to pain in right side. No hæmatemesis or melæna. Pronounced nausea but no vomiting, except in last three weeks, during which time has vomited twice.

Physical, March 8. Well nourished. Few small glands in submaxillary triangle, axillæ, and groins. Sense of resistance in abdomen and pronounced tenderness. Hæmoglobin, 92 per cent. White blood-corpuscles, 8600. Test meals, free HCl, 70. Combined acid, 10. Total acidity, 95. Microscopic, occasional red blood-corpuscles.

March 14, distinct hard globular mass, palpable just above and to right side of umbilicus.

Urine. Albumen present. Large hyaline and small granular casts.

Operation, March 22, 1905. Dr. Howard Lilienthal. Thickened stenosed pylorus high above liver, making external palpation of mass difficult. Maury's twine triangular stitch inserted posteriorly.

March 23, patient reacted poorly owing to nephritic involvement. Nauseated, noisy, stupid. Vomited coffee-ground material.

March 24, condition bad, face twitching. Labored, rapid breathing; high tension pulse.

March 27, uræmic symptoms less marked. Very weak but better.

March 28, general condition not satisfactory. Fluid in lungs. Melæna. Primary union of wound.

March 29, patient died in afternoon.

March 30, wound examination. Pylorus involved in large abscess cavity, which seemed to have sprung from a gastric ulcer. It was entirely walled off from the peritoneal cavity. The Maury stitch had not entirely cut through, but necrosis of the enclosed triangles was pronounced, and there was drainage at the angles.

The material employed in making this stitch was heavy silk. It had broken when first tied, and when introduced the second time could not be tied as tightly as the technique requires. This accounts for delay in total sloughing of the triangle, and shows that even the heaviest pedicle silk is not strong enough to employ for the triangular stitch technique.

CASE VI.—G. W.; aged forty-two years; born in Ireland; occupation, iron-moulder. Admitted to St. Luke's Hospital, February 16, 1905. Operation, March 1. Died March 4.

Family history negative.

Past history, scarlet fever and whooping-cough. At age of ten years severe typhoid, no complications. For the past twelve years has been subject about once a month to sour stomach, eructations of gas, and feeling of fulness in throat shortly after eating. Nasal catarrh at intervals for the past four years. Since boyhood has had occasional swellings of left scrotum with tenderness lasting from a few hours to one-half day with no relation to time of day, position, nor straining. Bowels regular up to June. Non-alcoholic, non-venereal, small eater, no renal, pulmonary, or cardiac diseases.

Present history. In June, 1904, had an attack of severe nausea with vomiting and pain in the right side extending up to the epigastrium. Similar attacks recurred once or twice a day, lasting usually about half an hour, most frequent during the night, from June to October. Pain was burning in character. During October pain became less and less frequent, disappearing by November. During latter month and December was entirely free from trouble, regaining twenty-five pounds lost from June to October.

January 1, 1905, following eating of some cheese, had similar attack of severe nausea, with vomiting and recurrence of pain

in right side and epigastrium. Eructations of gas were frequent and annoying. Up to present time (February 16) has had two attacks daily, usually at night. Pain in side not so severe as in former attacks; has lost about twenty-five pounds since January, and has taken medicine to keep the bowels open.

Chief complaint. Frequent attacks, usually nocturnal, of nausea, vomiting, pain in right side, eructations of gas.

Gastric analysis, negative. Free hydrochloric, 44. No lactic acid.

Operation, March 1. Maury's twine triangular ligature, Dr. Robert Abbe.

The stomach was found to be markedly dilated, and the pylorus would not even admit the tip of the little finger. The triangular stitch was placed between the posterior gastric wall and the upper portion of the jejunum, and an entero-anastomosis between the distal and proximal loops was made. Entire time of operation, twenty-five minutes. Patient reacted well after operation. Vomited a little coffee-ground material, but had no pain or discomfort worth naming. Forty-eight hours after operation the temperature suddenly shot up. The patient's general condition became very bad, and 100 hours from time of operation he died.

Post-mortem by Dr. Wood, the hospital pathologist. Lungs showed an acute diffuse pneumonia grafted upon an old and bilateral tuberculous lesion. The pneumonic process was very extensive and was the cause of death. Capacity of stomach, 2200 cubic centimetres.

The triangular ligature had not cut through nor had drainage begun at the angles.

Microscopic examination of the tissues contained in the triangles showed that necrosis in the path of the twine stitch was well advanced. Sloughing of the included tissue would have taken place had not death, due to pneumonia, arrested the process.

Case VII.—Mrs. C. W., aged forty-five years, admitted to the German Hospital, April 22, 1905; married; two children, both in good health; has had more or less stomach trouble since her fourteenth year, after an attack of scarlet fever. For last two years has had more trouble from stomach, with steady loss of flesh and strength; occasional vomiting, but never blood. Always constipated; frequent pain in epigastrium and back and

especially in left side of abdomen; taking food caused considerable distress and eructation of gas, but no vomiting; pain, however, was apparently independent of food-taking. Progressive increase of symptoms. Status præsens, anæmic, slightly icteric woman; small, very hard mass, about the size of a mandarin, is situated in epigastrium, slightly to the left, very irregular, descends with deep inspiration; spleen not enlarged; liver not palpable; some enlarged inguinal glands.

Operation, April 26, Dr. Willy Meyer. Incision above umbilicus; stomach low; middle of small curvature seat of infiltrating mass, firmly attached to spleen, which also seems somewhat hard. Stomach drawn inward at this place, slightly hour-glass-shaped. Many infiltrated glands. Diagnosis doubtful: malignant tumor or ulcer, perhaps carcinoma or basis of old ulcer. Posterior gastro-enterostomy difficult on account of adhesions between transverse mesocolon and gastric wall; an irregular portion can be pulled forward through the rent in the mesocolon and stitched to the latter's border; about ten posterior, interrupted silk sutures. Then gastro-enterostomy with the help of twine, according to Maury; continuous silk suture in front. Additional entero-enterostomy by means of elastic ligature, about fifteen centimetres away from new anastomosis.

Patient stood operation well. Pulse 84 at completion of operation.

April 28, doing very well indeed; normal pulse and temperature.

Postoperative history.—April 28, patient vomited intermittently. This continued until May 1. Daily lavage. On May 1 the vomitus had a distinctly fæcal odor. On May 2 there was little blood in vomit. On May 3 she had a violent vomiting spell while her stomach was being washed. From that time on the vomiting suddenly ceased, and she passed on to uneventful recovery. On May 13 patient had not yet passed either the twine ligature or the elastic ligature. She was able to eat all kinds of solid food without the slightest discomfort, and she stated that now, for the first time in two years, she had been able to take solid material without subsequently vomiting it.

Case VIII.—Mrs. X.; housewife; French Alsatian; thirty-five years of age. Simple stricture of the pylorus of several years' standing, during which time she had been subjected to every sort of treatment. Operation, Maury's triangular stitch, by Dr. Joseph

J. Noll, May 16. Anterior gastro-enterostomy without entero-enterostomy. The stitch was placed near the pylorus. Postoperative history was uneventful except for obstinate vomiting; the patient's pulse, however, remained below 100 throughout. The twine had not passed by rectum. There was every clinical evidence that it had cut through on or about the fourth day. Dr. Noll regarded the operation as perfectly successful.

A study of these eight cases shows that the stitch takes somewhat longer to cut out in man than in animals. The explanation of this probably is that the human stomachs operated upon have been very much thickened, and therefore more resistant than the normal animal organ. Dr. Lilienthal has demonstrated that silk should in no case be used, and that a loosely twisted linen twine which cannot possibly be broken by the hand is the material of choice. He has further demonstrated that the less twist there is in the twine, or, in other words, the straighter the fibre, the less disposition is there for it to stretch after it has been inserted.

The mortality attending these operations has been high. In Dr. Lilienthal's first case it was due, in his own words, to an error in judgment in closing the alimentary canal, although it may be noted that the walls of this stomach were so œdematous that a failure of union was almost to be looked for. The triangular stitch had not sloughed out in this case, but necrosis of the triangles was well advanced, and there was drainage at the angles.

Dr. Lilienthal's second fatal case is seen to be due to the nephritic involvement following prolonged abscess formation. Here again drainage had begun through the angles of the triangles and necrosis was well advanced.

In Dr. Abbe's case, which lived 100 hours, there is positive microscopic evidence that the triangles would have sloughed out had the patient not succumbed to anæsthetic pneumonia.

Dr. Meyer, as is well known, has for years been a stanch advocate of the McGraw elastic ligature. While talking with him about the advantages of the twine in the place of the ligature, he said that last year, while operating for Professor

Von Bergmann, he had asked him to demonstrate the McGraw technique. No suitable elastic being at hand, a very inferior and questionable piece was made use of. Dr. Meyer said that this occasion called to his mind very forcibly at least one of the advantages of the twine over the ligature, namely, that it is always available. It is with pleasure that I quote the following lines from a letter recently received from Dr. Meyer: "I take this opportunity of once more expressing to you my compliments on having devised this excellent method. I certainly consider it an important addition to our operative resources in gastro-enterostomy."

It must never be lost sight of that the success of the technique depends entirely upon tightening the knot with all one's strength.

SUMMARY OF LABORATORY CASES.

From the 10th of November, 1904, to the 24th of February, 1905, twenty-nine dogs and one hog were operated.

On seventeen dogs, the twine triangular gastro-enterostomy was done, and in thirteen of these the pylorus or some region of the upper gut was tied off, either at time of operation or at a subsequent period.

The Y gastro-enterostomy has been done on five dogs.

Seven dogs were experimented upon in connection with other work.

In one hog two gastro-enterostomies were done February 2. The animal is still in excellent condition.

Of all these dogs, four died as the result of evagination of the cut ends of the gut. Three died of the tetanoid symptoms referred to.

Three died owing to faulty technique, gut punctures, etc.

Fifty per cent. of the dogs who underwent the modified technique of cutting out the centre of the triangle died of peritonitis.

No dogs have died of peritonitis directly the result of the twine triangular stitch.

There has been one failure of the stitch to cut out, owing to its not being tied tight enough.